

PCT

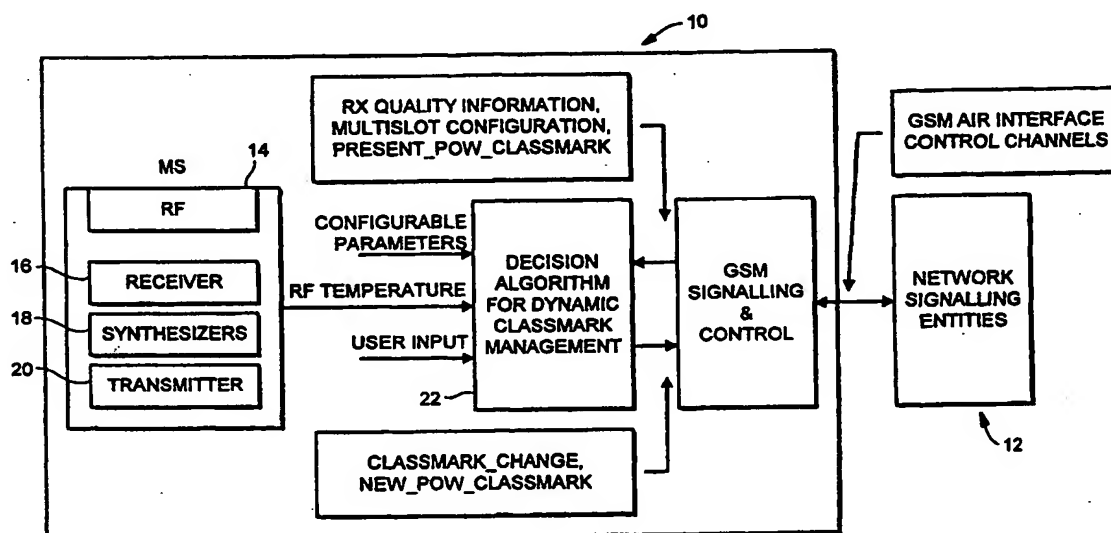
WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau



INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁷ : H04B 7/26		A1	(11) International Publication Number: WO 00/01094
			(43) International Publication Date: 6 January 2000 (06.01.00)
(21) International Application Number: PCT/EP99/04503			(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).
(22) International Filing Date: 28 June 1999 (28.06.99)			
(30) Priority Data: 9814080.9 30 June 1998 (30.06.98) GB			
(71) Applicant (for all designated States except US): NOKIA MOBILE PHONES LIMITED [FI/FI]; Keilalahdentie 4, FIN-02150 Espoo (FI).			
(72) Inventors; and (75) Inventors/Applicants (for US only): KNUUTILA, Jarno [FI/FI]; Matti Tapion Katu 1 F 17, FIN-33720 Tampere (FI). HAMALAINEN, Jari [FI/FI]; Nallekarhantie 20, FIN-36100 Kangasala AS. (FI). AHO, Ari [FI/FI]; Elementin Polku 13 A6, FIN-33720 Tampere (FI). SALMINEN, Ari [FI/FI]; Vuorikuja 4 AS. 19, FIN-24100 Salo (FI). LIPPONEN, Markku [FI/FI]; Simo Kaarion Katu 1 A 2, FIN-33720 Tampere (FI).			
(74) Agents: HAWS, Helen, Louise et al.; Nokia IPR Dept., Nokia House, Summit Avenue, Farnborough, Hampshire GU14 0NG (GB).			Published With international search report.

(54) Title: DATA TRANSMISSION IN A TDMA SYSTEM



(57) Abstract

In TDMA systems it is possible to transmit data on more than one consecutive slot per frame. This introduces increased workloads on the power amplifier of the transmitter of the mobile station. To prevent the power amplifier from overheating, temperature sensing means are incorporated into the mobile station which output to a control system comprising a comparator and feedback means which together regulate the operation of the transmitter if the power amplifier approaches or exceeds its upper rated operating value, thereby preventing the power amplifier from damage.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece			TR	Turkey
BG	Bulgaria	HU	Hungary	ML	Mali	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MN	Mongolia	UA	Ukraine
BR	Brazil	IL	Israel	MR	Mauritania	UG	Uganda
BY	Belarus	IS	Iceland	MW	Malawi	US	United States of America
CA	Canada	IT	Italy	MX	Mexico	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NE	Niger	VN	Viet Nam
CG	Congo	KE	Kenya	NL	Netherlands	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NO	Norway	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	NZ	New Zealand		
CM	Cameroon			PL	Poland		
CN	China	KR	Republic of Korea	PT	Portugal		
CU	Cuba	KZ	Kazakhstan	RO	Romania		
CZ	Czech Republic	LC	Saint Lucia	RU	Russian Federation		
DE	Germany	LI	Liechtenstein	SD	Sudan		
DK	Denmark	LK	Sri Lanka	SE	Sweden		
EE	Estonia	LR	Liberia	SG	Singapore		

Data Transmission in a TDMA System

5 The present invention relates to a method and apparatus for data transmission by a mobile station in a Time Division Multiple Access (TDMA) system. More specifically, the invention concerns multi-slot transmission of data services in such a system.

10 TDMA is a fundamental digital telecommunication technology and forms the basis of cellular standards such as Global System for Mobile Communications (GSM). A TDMA system includes the basic subsystems of cellular radio systems including a switching network, base stations and mobile stations (MS). In a TDMA system the radio spectrum is divided into radio carrier frequencies typically spaced 30 kHz to 200 kHz apart. This spacing between
15 the carrier frequencies is the nominal or effective bandwidth of the total multi-channel multiplexed signal. Digital techniques are employed at the base station and in the cellular radio to subdivide the time on each radio channel into time slots, i.e. the TDMA radio carrier waveform is divided into several different types of control and voice/data channels by the use of different time
20 slots or shared portions of time slots. Time slots are the smallest individual time periods available to each mobile station. Each time slot can be assigned to a different mobile telephone, and the time slots can be dedicated or dynamically assigned. Voice or data information as well as access information are converted to digital information that is sent and received in bursts during
25 the time slots. The burst of digital information can be encoded, transmitted, and decoded in a fraction of the time required to produce the sound. Therefore, only a fraction of the airtime is used by one channel, and other subscribers can use the remaining time slots on the radio channel. The result is that TDMA systems allow several mobile stations (MS) to operate

simultaneously on a single radio carrier frequency because the mobile stations share the radio frequency by dividing their signals into slots.

In the GSM system, eight mobile telephones are able to share a single 200 kHz bandwidth radio carrier waveform for voice or data communications. GSM uses a type of radio channel called a traffic channel (TCH) which carries voice, data, and control information. The TCH is organised into frames and time slot bursts. The entire repeating pattern of time slots is called a frame and comprises eight time slots assigned to eight different users. From each frame, each user is assigned to a particular time slot burst for reception, and a particular corresponding burst for transmission. Hence, GSM multiplexes (time shares) several users onto a single radio carrier frequency through use of distinct time slots from each frame to individual users. Thus the GSM radio channel structure allows multiple mobile stations to communicate on the same frequency by using different time slots on the radio channel.

As is well understood, such intensified use of radio spectrum greatly multiplies subscriber capacity. A further advantage of digital cellular technology is its ability to support advanced high speed data services such as short message service (SMS), broadcast paging, imaging services and fax transmission.

Data services ordinarily are communicated in the same way as voice signals, that is they are assigned a particular individual time slot in a frame and share the single bandwidth radio carrier with other users. However, whilst the transfer of voice signals must be on a real time basis (instantaneous), certain data services can be transferred on a non-real time basis (stored or delayed). For example because paging messages can be delayed for several minutes without significant disadvantages to the receiver of the message, it allows short paging messages to be placed in a queuing system. Voice services on

the other hand cannot queue an incoming call for more than a few seconds otherwise it is likely that the caller would terminate the call.

Non-real time operability of data services allows transmission of the
5 information to be treated with increased flexibility. This has led recently to the development of multi-slot data transfer capability. Multi-slot transmission is facilitated by the network, typically the base station, which controls channel allocation to users. If more than one slot in a frame is available (for instance during a period of relative inactivity and the slots have not be allocated to
10 other users) then the network may designate the available slots to the transfer of data services. Accordingly, the network will command the mobile station to transmit the data communication on more than one consecutive slot. The data can then be decoded from the multi-slot transmission in the network.

15 The present invention aims to address the problems arising from multi-slot transmission, and accordingly, in one aspect, provides a method for controlling a transmitter of a portable radio communication apparatus for communication in a radio communication network employing transmission by a plurality of carrier frequencies in frames each consisting of a predetermined
20 number of time slots, the transmitter transmitting data bursts during one or more of said time slots in a frame, the method comprising monitoring at least one criterion associated with heat generated by the transmitter, providing a signal responsive to the at least one monitored criterion for controlling at least one output criterion of the transmitter.

25

It has been noted by the present inventors that current design of mobile station transmitters would not be able satisfactorily to cope with multi-slot transmission. One particular drawback is that the output RF power amplifier in standard TDMA mobile stations are designed to transmit at a rate of one slot
30 per frame. In multi-slot transmission, driving the power amplifier at increased

rates introduces new design challenges. In particular, it has been anticipated that driving the power amplifier for multi-slot transmission will introduce problems due to thermal effects. Specifically, if the junction temperature of the RF power amplifier exceeds its upper rating, then this would cause changes in the amplifier's operating characteristics and could lead to irreversible damage.

One approach to this problem could be to increase the power amplifier capacity and introduce further heat sinks in the mobile station. However, this would necessitate an increase in the size of the mobile station, which would be undesirable given the general trend towards more compact mobile stations.

The present inventors have recognised that an alternative approach is to limit the power output of the power amplifier while continuing to transmit in multi-slot mode by controlling the maximum allowed output power levels.

The maximum allowed power output of a mobile station transmitter depends on its allocated power classification, which is network controlled. The network chooses the transmission power of the mobile station, and commands to regulate it are issued to the mobile station. The network determines the required mobile station transmission power through reception level measurements performed on the base station, taking into account the mobile station maximum transmission power as well as quality measurements done by the network; this last parameter helps to ensure that transmission quality is kept above some acceptance threshold.

At the start of a connection, the network chooses the initial value of the transmission power. Because the equipment of the user may be changed without warning the operator (subscription is linked to the SIM (Subscriber Identity Module), not to the mobile equipment), this indication must be given at

the beginning of each new connection based on the RF power capability, known as the transmission power class, which refers to the maximum power the mobile station is able to transmit. This information is used for power control and handover preparation.

5

GSM has five power classmarks defining respective maximum output powers. Typical classes in GSM900 are class 2 for transportable mobile telephones (eg. vehicle-mounted equipment) with a maximum power output of 8 watts; hand portables are classified 3 through to 5 with maximum power outputs ranging from 5 to 0.8 watts.

10

Whilst the classmark is sent by the mobile station in the initial message, at the beginning of the data transmission it may happen that the classmark changes during the transmission. An example of this is mobile equipment consisting of a handheld part and a vehicle mounted part including an RF transmitter, with the possibility to connect and disconnect the two parts during a communication. Then the power class changes, and the new value must be provided to the network. To achieve this, a classmark change procedure must be executed. In the GSM specification the classmark change procedure is described in GSM 04.08 in section 3.4.10.

15

20

By means of the invention, if it is determined that the heat generated by the transmitter of the portable radio apparatus approaches or has for example exceeded a pre-determined limit, then the output of the transmitter is regulated to ensure that the transmitter remains safely within its operating range.

25

Instead of, and/or as well as, monitoring the temperature of the transmitter, it is possible to monitor the temperature of the portable radio communication

apparatus itself, and then to regulate transmission based on this temperature reading.

Conveniently, maximum and/or minimum pre-determined limits could be set.

- 5 Optionally, intermediate values can also be set.

In one embodiment, the method comprises controlling the output power of the transmitter based on the monitored temperature, preferably changing the portable radio communication apparatus power classmark when the
10 monitored temperature exceeds a pre-determined upper limit. As a result, the power amplifier output of the transmitter is reduced so that the temperature of the power amplifier does not reach or exceed its rated value.

In a second embodiment, the method comprises controlling the number of
15 data bursts transmitted on time slots in a frame, preferably decreasing the number of data bursts transmitted on time slots in a frame when the monitored temperature exceeds a pre-determined limit. Regulating the multi-slot transmission in this way protects the transmitter from overstretching its transmission capabilities.

20

If more than one heat generated determining criterion is monitored, then it is possible to provide more than one signal responsive to the monitored criteria, the signals then controlling respective output criteria of the transmitter.

25 It is preferred that the method is performed by the portable radio communication apparatus, which advantageously stores the pre-determined limits in memory registers. Hence the operation of the transmission of the transmitter can be controlled by the portable radio communication apparatus automatically and independently from the network.

30

Optionally, the method can be performed by the radio communication network.

In a further aspect of the invention, there is provided a method for controlling
5 a transmitter of a portable radio communication apparatus for communication
in a radio communication network employing transmission by a plurality of
carrier frequencies in frames each consisting of a predetermined number of
time slots, the transmitter transmitting data bursts during one or more of said
time slots in a frame, the method comprising monitoring the number of data
10 bursts transmitted on time slots in a frame, comparing the monitored number
with a pre-determined limit, and changing the operation of the transmitter if
the monitored number falls outside the pre-determined limit.

According to this aspect of the invention, if it is determined that the transmitter
15 of the portable radio apparatus has for example exceeded a pre-determined
limit of data bursts in a particular frame, then the operation of the transmitter
can be regulated to account for this and adjusted accordingly.

In a preferred embodiment, the monitoring of the number of data bursts
20 transmitted on time slots in a frame is performed over a predetermined period
of time or pre-determined number of frames.

If the monitored number of transmitted data bursts exceeds a pre-determined
limit then the output power of the transmitter can be decreased,
25 advantageously by changing the classmark of the portable radio
communication apparatus. As a result, the maximum available output power
amplifier output of the transmitter is reduced so that the temperature of the
power amplifier does not reach or exceed its rated value.

This class mark change can occur either in the call set-up or during high speed data transmission typically, but not restricted to, the moment when the number of used time slots is down or upgraded, or the temperature of the transmitter will reach a given limit.

5

The invention includes a method for controlling a transmitter of a portable radio communication apparatus, the portable radio communication apparatus communicating with a radio communication network over a radio channel comprising a plurality of time slots, and the transmitter transmitting data bursts during one or more of said time slots, the method comprising monitoring the transmission power level and comparing the monitored transmission power level with a pre-determined limit and changing the transmission power level of the communication apparatus based on the monitored transmission power level.

15

By continually monitoring the transmission power level, and comparing this with pre-determined values, the transmission level of the portable radio communication apparatus can be dynamically optimised.

20 The invention extends to radio systems and portable radio communication apparatus comprising means for performing the methods as described herein.

The invention will now be described by way of example, with reference to the accompanying drawings in which:

25

Figure 1 is a block diagram of one embodiment of the present invention;

Figure 2 is a block diagram illustrating in greater detail the embodiment of Figure 1;

30

Figure 3 is a schematic diagram of network originated resource upgrading in HSCSD; and

Figure 4 is schematic diagram of user initiated service level up and
5 downgrading.

In the block diagram cellular telephone system shown in Figure 1, a mobile station 10 communicates with the network 12, transferring data and digitised voice signals in a two way radio communication link. The cellular network 12
10 typically comprises an array of base stations which are linked together either directly or indirectly via mobile switching centres, and which enable telephone calls to be routed between mobiles stations as well as landline telephones.

The mobile station 10 is equipped with the standard features associated with
15 a mobile communication device: a keypad for dialling numbers, accepting a call, terminating a call, storing telephone numbers, and so on; a microphone for converting sound pressure waves into electrical signals, and a loudspeaker for converting electrical signals into sound pressure waves; an antenna for radiating electromagnetic waves at transmission frequencies
20 during transmission, and during reception for converting received electromagnetic waves at reception frequencies into electrical signals. The mobile station 10 also includes an RF block 14 comprising a receiver 16, synthesizers 18 and a transmitter 20.

25 It has previously been explained that in a TDMA system, and in particular GSM, a recent development in data services has been that of multi-slot transmission, for example, approaches such as High Speed Circuit Switched Data (HSCSD) and General Packet Radio Services (GPRS). Briefly, HSCSD is based on the use of up to 8 time slots per TDMA frame for one
30 communication, thus providing for higher data transmission speeds. Typical

applications of HSCSD include, facsimile, file transfer, electronic mail, video and distribution services. GPRS provides high speed packet radio access for GSM mobile stations and routing protocols for the GSM network. The relevant GSM standards of HSCSD and GPRS are GSM 02.34, 03.34 and GSM 03.64
5 respectively.

In a multi-slot transmission operation, the transmitter 20 outputs on more than one time-slot per TDMA frame. The power amplifier of the transmitter accordingly is driven at an increased rate compared to normal transmission at
10 one slot per frame. This leads to an increase in the operating temperature of the power amplifier. If multi-slot transmission is sustained the temperature of the power amplifier will continue to rise. If unchecked, the rise in operating temperature of the power amplifier will cause damage to it.

15 Thus in one embodiment of the present invention the transmitter power amplifier (or adjacent area) is provided with a temperature sensor 21 (see Figure 2) for monitoring the temperature of the transmitter 20, and in particular the power amplifier. The temperature sensor 21 continually takes a reading of the temperature of the transmitter and feeds this reading, either continually or
20 periodically, to a dynamic classmark control system 22 which includes an algorithm for deciding the operation of the transmitter. Specifically, the algorithm can decide the maximum allowed output power level and/or the maximum allowed number of transmitted bursts per TDMA frame.

25 The control system 22 stores certain system parameters and operating characteristics, such as information about the power amplifier including operating temperature limits and pre-defined maximum transmission power levels. Such information is stored in the mobile station's non-volatile memory area or hardware registers. This would normally be factory set, but could be
30 user defined. The control system 22 further includes a comparator which

takes the sensed temperature reading and compares this against the stored preferred operating temperature range of the power amplifier. On the basis of the result of the comparator, the control system 22 decides whether or not to change the maximum allowed power output or the burst rate at which the power amplifier is being driven. If the result from the comparator is that the sensed temperature of the power amplifier is within its operating range then the control system 22 directs no changes in the normal transmitter operation. If however the sensed temperature is outside its preferred operating range then the control system 22 commands a change in the operation of the transmitter to ensure that the upper working limit of the power amplifier is not reached.

One approach is that it is the mobile station power classmark that is dropped, as a result reducing the maximum allowed power output of transmitter and thereby demanding less from the power amplifier. Another approach is that the number of multi-slot transmissions per frame is decreased. This is particularly beneficial where a drop in the power classmark could risk losing the connection altogether.

In and HSCSD operation, typically the right moment for classmark change is after the resource upgrading procedure, which can be initiated either by the network or on the mobile station side. The implementation is mainly adding a control entity for taking care of the mobile station classmark during the data transmission operation. Figures 3 and 4 illustrate HSCSD operation.

25

In the GPRS communication, the mobile station delivers its Mobile Radio Capabilities, including information about its power class, in an Attach procedure. This procedure is carried out when the mobile station initiates the GPRS "session". This information is stored in the Serving GPRS Support Node (SGSN) and the SGSN delivers it to the base station system when the

30

mobile moves around the network. The Mobile Radio Capability information is provided to the SGSN by the mobile station also in the Routing Area Update, i.e. when the mobile station is moving around the network. It is also possible that the Mobile Radio Capability information is delivered by the mobile station to the base station when the mobile station enters the GPRS transfer mode, i.e. every time the mobile is going to send or receive data and when the physical radio channel is needed. This can be done for example in the Packet Resource Request message that is transmitted on the Packet Associated Control Channel (PACCH). These kinds of messages may be transmitted on the channel given for the mobile station, instead of user data messages. This procedure allows the mobile station to change its power class dynamically during the GPRS "session".

In a second embodiment, a direct temperature sensor is no longer employed, and the temperature of the transmitter is determined or estimated by indirect means. In this embodiment, a transmission monitor is provided for counting the number of consecutive multi-slot time slot transmissions effected by the transmitter. The monitor also counts the number of frames of multi-slot transmission. Accordingly, in a given time period, the total output burst rate of the power amplifier and the power dissipation which turns to heat can be continually determined and updated. The monitoring can be performed on a continually updating and dynamic basis. This can be fed into the control system 22 and compared with pre-defined operating values concerning the number of multi time slot transmissions over a certain number of frames. If the number of transmissions over a certain period of time is within the operating range of the power amplifier then the control system 22 allows it to continue the transmission. However, if the counted transmission approaches or exceeds the upper limit of transmissions over a period of time or number of frames, (known to cause an unacceptable temperature rise of the transmitter, or mobile station when operating at high output power levels), then the control

system 22 effects a change in the transmitter: either reducing the number of multi-slot transmissions or changing the mobile station power classmark.

For example, it may be that the transmitter is transmitting in GSM at a rate of
5 8 time slots per frame, the mobile station will have stored in a memory the number of frames in which 8 time slots can be transmitted on before the power amplifier begins to reach its critical limit. This information is used by the control system in determining the operation of the transmitter. It will be understood that a power amplifier operating at 8 time slots per frame will
10 reach its critical limit sooner than if it was operating at say only 4 time slots per frame. Equally, at 4 time slot transmissions per frame the power amplifier can output a greater number of consecutive frames at this rate than operating at 8-time slot transmission per frame before approaching its critical value. These critical values are stored in an on-board memory facility which either
15 can be readily accessed by the control system or form part thereof.

The control system ensures that the maximum allowed transmission power level (ie. the MS classmark or the number of bursts per TDMA frame) is according to the predefined criteria.

20

It should be noted that whilst the feedback control systems of the invention have been described in the context of a portable radio communication device, such systems, and indeed aspects of the systems, can be implemented and supported in the network.

25

Furthermore, it will be readily understood that alternative arrangements to those described above with reference to the specific embodiment can be made within the inventive concept as defined in the appended claims.

Each feature disclosed in this specification (which term includes the claims) and/or shown in the drawings may be incorporated in the invention independently of other disclosed and/or illustrated features.

- 5 The appended abstract as filed herewith is included in the specification by reference.

Claims

1. A method for controlling a transmitter of a portable radio communication apparatus for communication in a radio communication network employing transmission by a plurality of carrier frequencies in frames each consisting of a predetermined number of time slots, the transmitter transmitting data bursts during one or more of said time slots in a frame, the method comprising monitoring at least one criterion associated with heat generated by the transmitter, providing a signal responsive to the at least one monitored criterion for controlling at least one output criterion of the transmitter.
2. A method according to claim 1, wherein one of the at least one monitored criterion comprises the temperature of the transmitter.
3. A method according to claim 1 or claim 2, wherein one of the at least one monitored criterion comprises the number of transmitted data bursts in a frame.
4. A method according to any preceding claim, wherein one of the at least one output criterion comprises the power output of the transmitter.
5. A method according to claim 4, wherein if the monitored criterion exceeds a predetermined limit then the power output of the transmitter is decreased.
6. A method according to claim 5, wherein the maximum available power output of the transmitter is decreased by changing the power classmark of the portable radio communication apparatus.

7. A method according to any preceding claim, wherein one of the at least one output criterion comprises the number of data bursts transmitted in a frame.
- 5 8. A method according to claim 7, wherein if the monitored criterion exceeds a predetermined limit then the number of data bursts transmitted in a frame is decreased.
9. A method according to any preceding claim, wherein the monitoring step is
10 performed by the portable radio communication apparatus.
10. A method according to any of claims 1 to 8, wherein the monitoring step is performed by the radio communication network.
- 15 11. A method for controlling a transmitter of a portable radio communication apparatus for communication in a radio communication network employing transmission by a plurality of carrier frequencies in frames each consisting of a predetermined number of time slots, the transmitter transmitting data bursts during one or more of said time slots in a frame, the method
20 comprising monitoring the number of data bursts transmitted on time slots in a frame, comparing the monitored number with a pre-determined limit, and changing the operation of the transmitter if the monitored number falls outside the pre-determined limit.
- 25 12. A method according to claim 11, wherein the monitoring of the number of data bursts transmitted on time slots in a frame is performed over a predetermined period of time or pre-determined number of frames.

13.A method according to claim 11 or claim 12, wherein changing the operation of the transmitter comprises controlling the power output of the transmitter..

5 14.A method according to claim 13, wherein controlling the power output of the transmitter comprises changing the power classmark of the portable radio communication apparatus.

10 15.A method according to any of claims 11 to 14, wherein changing the operation of the transmitter comprises controlling the number of data bursts transmitted on time slots in a frame.

15 16.A method according to claim 15, wherein controlling the number of data bursts transmitted on time slots in a frame comprises decreasing the number of data bursts transmitted on time slots in a frame if the monitored number of transmitted data bursts exceeds a pre-determined limit.

20 17.A method according to any of claims 11 to 16, wherein the method steps are performed by the portable radio communication apparatus.

18.A method according to any of claims 11 to 16, wherein the method steps are performed by the radio communication network.

25 19.A method for controlling a transmitter of a portable radio communication apparatus for communication in a radio communication network employing transmission by a plurality of carrier frequencies in frames each consisting of a predetermined number of time slots, the transmitter transmitting data bursts during one or more of said time slots, the method comprising monitoring the transmission power level of the communication apparatus
30 and comparing the monitored transmission power level with a pre-

determined limit and changing the maximum allowed transmission power level in response to the monitored transmission power level.

5 20.A method according to claim 19, wherein the monitored transmission power level is compared with a pre-determined power transmission level and if the monitored transmission power level is above said pre-determined level then the maximum allowed output transmission power level is decreased by changing the power classmark of the portable radio communication apparatus.

10

21.A radio telephone system comprising a portable radio communication apparatus for communication in a radio communication network employing transmission by a plurality of carrier frequencies in frames each consisting of a predetermined number of time slots, the apparatus having a
15 transmitter for transmitting data bursts during one or more of said time slots in a frame, the system including monitoring means for monitoring at least one criterion associated with heat generated by the transmitter, at least one output criterion of the transmitter being responsive to the monitored criterion.

20

22.A radio telephone system according to claim 21, wherein one of the at least one monitored criterion comprises the temperature of the transmitter.

23.A radio telephone system according to claim 21 or 22, wherein one of the
25 at least one monitored criterion comprises the number of transmitted data bursts in a frame.

24.A radio telephone system according to any of claims 21 to 23, wherein one of the at least one output criterion comprises the power output of the
30 transmitter.

25. A radio telephone system according to claim 24, wherein if the monitored criterion exceeds a predetermined limit then the power output of the transmitter is decreased.

5

26. A radio telephone system according to claim 25, wherein the maximum available power output of the transmitter is decreased by changing the power classmark of the portable radio communication apparatus.

10 27. A radio telephone system according to any of claims 21 to 26, wherein one of the at least one output criterion comprises the number of data bursts transmitted in a frame.

15 28. A radio telephone system according to claim 26, wherein if the monitored criterion exceeds a predetermined limit then the number of data bursts transmitted in a frame is decreased.

29. A radio telephone system according to any of claims 21 to 28, wherein the portable radio communication apparatus includes the monitoring means.

20

30. A radio telephone system according to any of claims 21 to 28, wherein the radio communication network includes the monitoring means.

25 31. A radio telephone system comprising a portable radio communication apparatus for communication in a radio communication network employing transmission by a plurality of carrier frequencies in frames each consisting of a predetermined number of time slots, the apparatus having a transmitter for transmitting data bursts during one or more of said time slots in a frame, the system including monitoring means for monitoring the
30 number of data bursts transmitted on time slots in a frame, a comparator

for comparing the monitored number of transmitted data bursts with a pre-determined limit, and a processor for changing the operation of the transmitter if the monitored number of transmitted data bursts falls outside the pre-determined limit.

5

32.A radio telephone system according to claim 31, wherein the monitoring means monitors the number of data bursts transmitted over a pre-determined period of time or pre-determined number of frames.

10 33.A radio telephone system according to claim 31 or 32, wherein the processor controls the power output of the transmitter.

34.A radio telephone system according to claim 33, wherein the processor controls the power output of the transmitter by changing the power
15 classmark of the portable radio communication apparatus.

35.A radio telephone system according to any of claims 31 to 34, wherein the processor controls the number of data bursts transmitted on time slots in a frame.

20

36.A radio telephone system according to claim 35, wherein the number of data bursts transmitted on time slots in a frame is decreased when the monitored number of transmitted data bursts exceeds a pre-determined limit.

25

37.A radio telephone system according to claim 31 to 36, wherein the portable radio communication apparatus includes the monitoring means, comparator and the processor.

38. A radio telephone system according to claim 31 to 36, wherein the radio communication network includes the monitoring means, comparator and the processor.

5 39. A radio telephone system comprising a portable radio communication apparatus for communication in a radio communication network employing transmission by a plurality of carrier frequencies in frames each consisting of a predetermined number of time slots, the apparatus having a transmitter for transmitting data bursts during one or more of said time
10 slots in a frame, the system including monitoring means for monitoring the transmission power level of the transmitter and comparing means for comparing the monitored transmission power level with a pre-determined limit and a processor for changing the maximum available transmission power level of the communication apparatus in response to the monitored
15 transmission power level.

40. A radio telephone system according to claim 39, wherein the monitored transmission power level is compared with a pre-determined power transmission level and if the monitored transmission power level is above
20 said pre-determined level then the maximum allowed output transmission power level is decreased by changing the power classmark of the portable radio communication apparatus.

41. A portable radio communication apparatus operable to communicate with
25 a radio communication network employing transmission by a plurality of carrier frequencies in frames each consisting of a predetermined number of time slots, the apparatus having a transmitter for transmitting data bursts during one or more of said time slots in a frame, and including monitoring means for monitoring at least one criterion associated with the

heat generated by the transmitter, at least one output criterion of the transmitter being responsive to the monitored criterion.

42. A method for controlling a portable radio communication apparatus for communication with a radio communication network employing transmission by a plurality of carrier frequencies in frames each consisting of a predetermined number of time slots, the apparatus having a transmitter for transmitting data bursts during one or more of said time slots in a frame, the method comprising the steps of the apparatus registering a power classmark with the network, the apparatus monitoring at least one criterion associated with the heat generated by the transmitter, the apparatus sending a power classmark change request to the network responsive to the monitored criterion, and the network accordingly changing the power classmark of the portable radio communication apparatus.

1 / 4

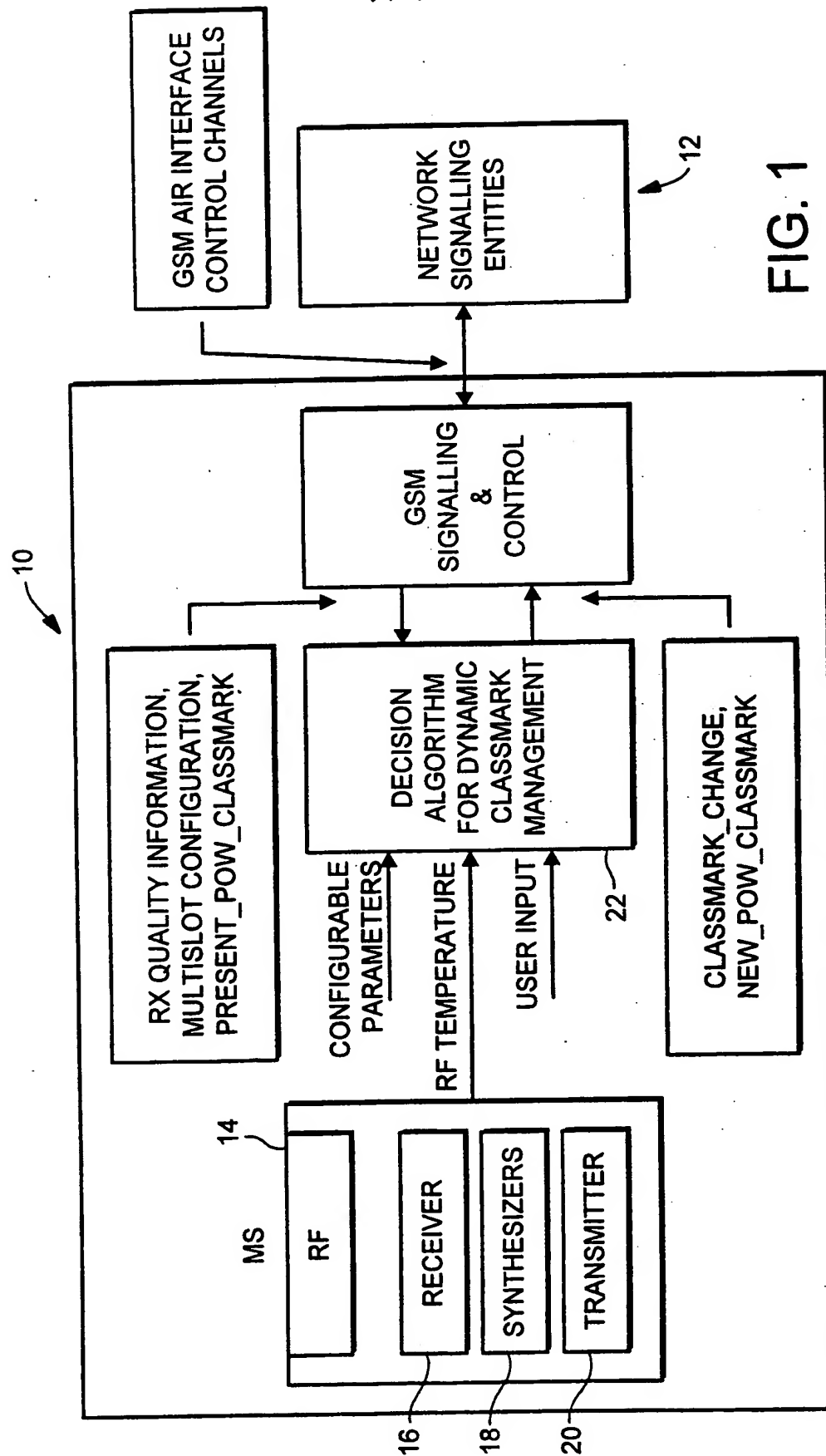


FIG. 1

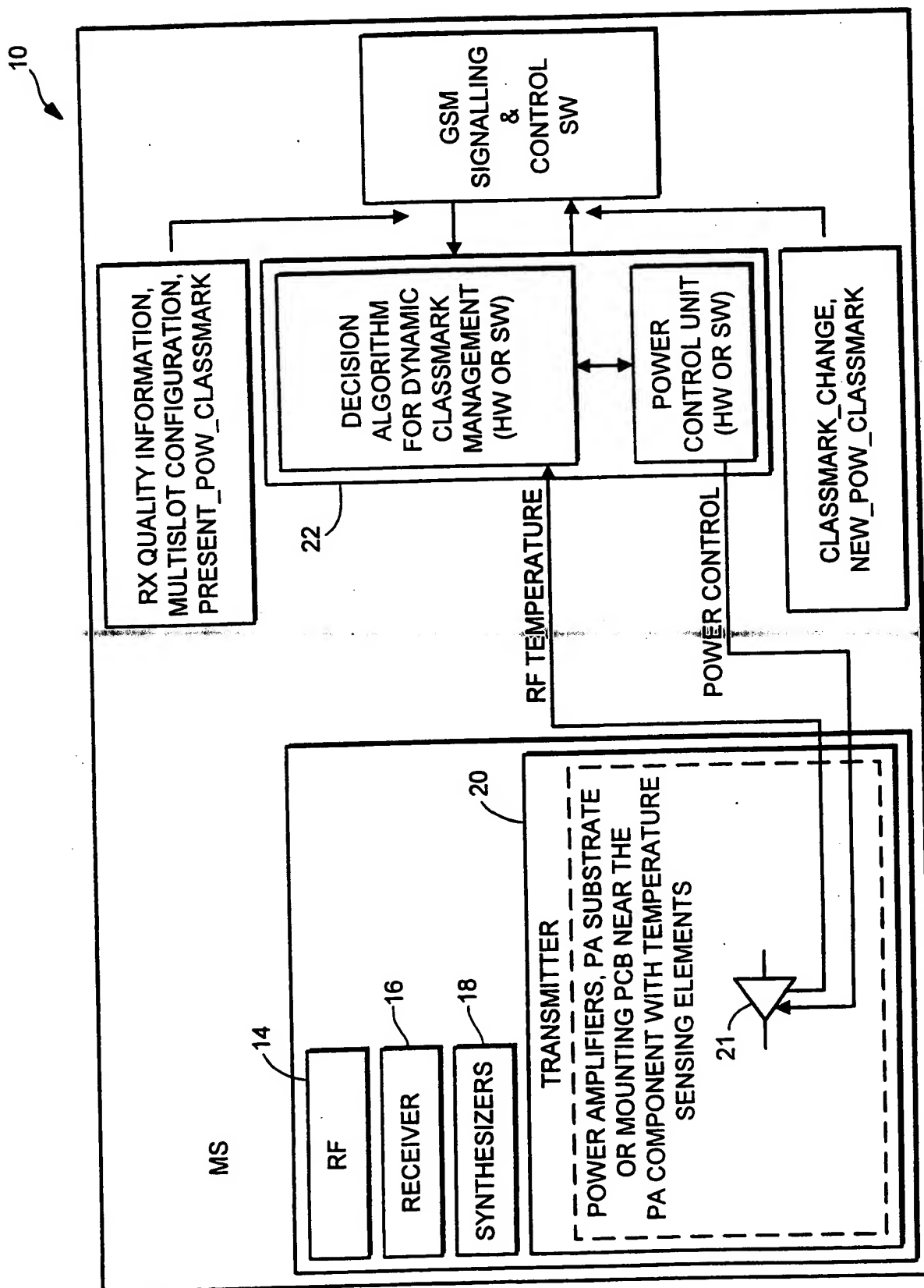


FIG. 2

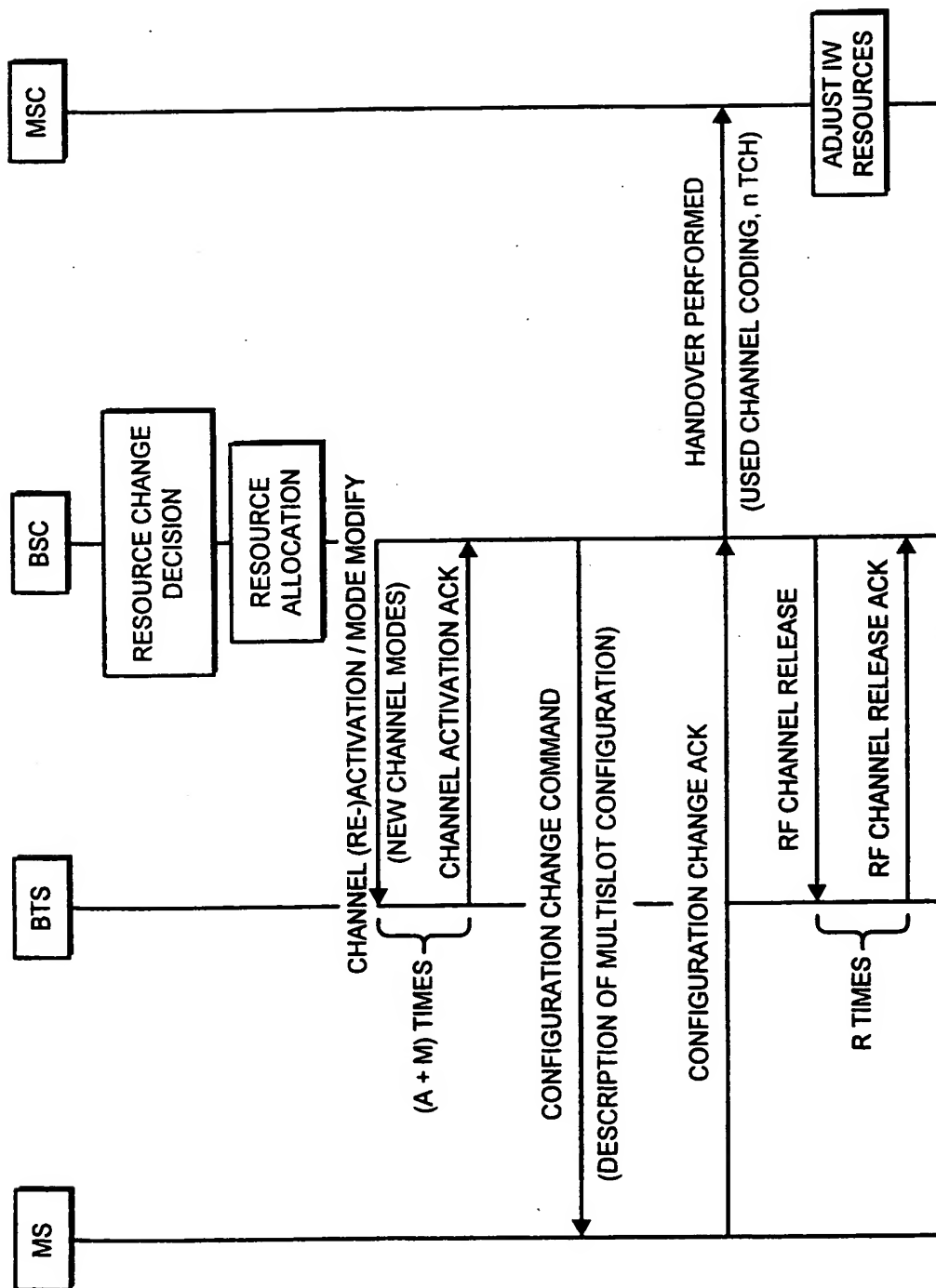


FIG. 3

A = NUMBER OF TIME SLOTS ADDED TO THE CONNECTION
 R = NUMBER OF TIME SLOTS RELEASED FROM THE CONNECTION
 M = NUMBER OF TIME SLOTS MODIFIED
 n = NUMBER OF TIME SLOTS AFTER UPGRADING / DOWNGRADING

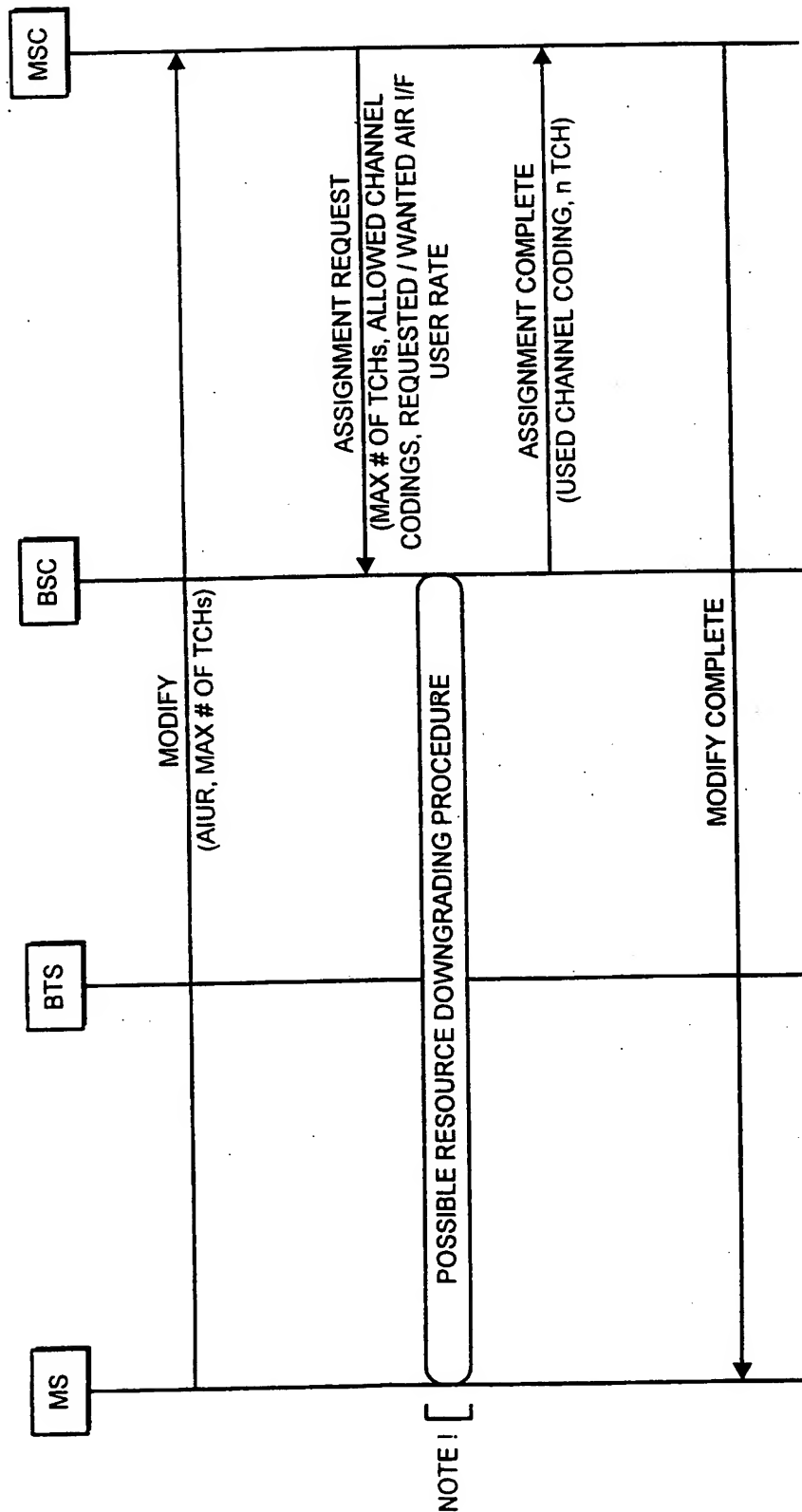


FIG. 4

AIUR = AIR INTERFACE USER RATE
n = NUMBER OF TIME SLOTS ALLOCATED

NOTE ! THE RESOURCE LEVEL IS DOWNGRADED, IF IT IS CONTRADICTION WITH THE NEW SERVICE LEVEL

INTERNATIONAL SEARCH REPORT

International Application No

PCT/EP 99/04503

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04B7/26

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 H04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	<p>US 5 774 797 A (SAKATA MINORU ET AL) 30 June 1998 (1998-06-30)</p> <p>abstract column 5, line 21 -column 16, line 46 figures 1,3,6</p> <p>& JP 08 204587 A (FUJITSU LIMITED) 9 August 1996 (1996-08-09)</p> <p>---</p> <p>-/--</p>	<p>1,2,4,5, 9,21,22, 24,25, 29,39,41</p> <p>3,6-8, 10-20, 23, 26-28, 30-38, 40,42</p>



Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

Special categories of cited documents:

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- "&" document member of the same patent family

Date of the actual completion of the international search

7 October 1999

Date of mailing of the international search report

15/10/1999

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040. Tx. 31 651 epo nl.
Fax: (+31-70) 340-3016

Authorized officer

Tzimeas, K

INTERNATIONAL SEARCH REPORT

International Application No

PCT/EP 99/04503

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 519 886 A (GILBERT STEPHEN S ET AL) 21 May 1996 (1996-05-21)	1,2,7-9, 21,22, 27-29,41
A	abstract figures 1-3 column 2, line 1 -column 4, line 64	3-6, 10-20, 23-26, 30-40,42
X	EP 0 800 282 A (NIPPON ELECTRIC CO) 8 October 1997 (1997-10-08)	1,2,7-9, 21,22, 27-29,41
A	abstract column 3, line 40 -column 8, line 1 figure 4	3-6, 10-20, 23-26, 30-40,42
X	US 5 287 555 A (WILSON GREGORY P ET AL) 15 February 1994 (1994-02-15)	19
A	abstract column 10, line 12 - line 43 claim 2 figure 9	1-18, 20-42

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/EP 99/04503

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 5774797	A	30-06-1998	JP 8204587 A	09-08-1996
US 5519886	A	21-05-1996	NONE	
EP 0800282	A	08-10-1997	AU 1664297 A	09-10-1997
			JP 9326740 A	16-12-1997
			US 5848062 A	08-12-1998
US 5287555	A	15-02-1994	CA 2089360 A,C	23-01-1993
			KR 9608412 B	26-06-1996
			MX 9204298 A	01-07-1993
			WO 9302505 A	04-02-1993

THIS PAGE BLANK (USPTO)